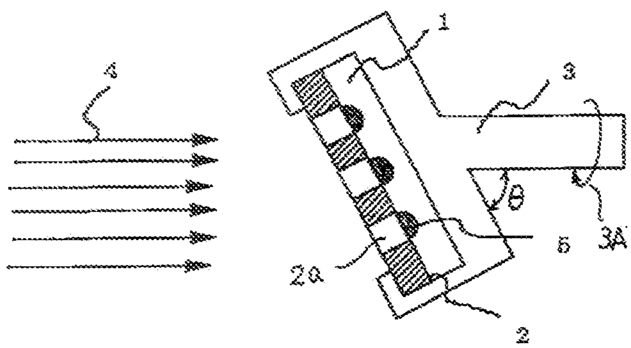
CLAIMS

[Claim(s)]
[Claim 1]A manufacturing method of planar microlens raising locally a refractive index of two or more of said fields by preparing a silica system glass substrate, and irradiating said two or more fields with X-rays so that a micro lens may be produced in each of two or more fields of said substrate.
[Claim 2]An X ray mask pattern which has two or more penetrable openings to said X-rays corresponding to each of said micro lens is arranged to relative position relation parallel substantially and fixed about the surface of said substrate. While said X-rays are irradiated by said substrate via said mask pattern, it is rotated by the surroundings of the fixed axis of rotation parallel to an optic axis of said X-rays, said substrate maintaining said relative position relation with said mask pattern, A manufacturing method of the planar microlens according to claim 1, wherein the surface of said substrate does not lie at right angles to said axis of rotation between the rotation.
[Claim 3]A manufacturing method of the planar microlens according to claim 2, wherein an angle which the surface of said substrate and said axis of rotation make is changed into said X-ray irradiation.
[Claim 4]An X ray mask pattern is substantially arranged in parallel about the surface of said substrate, Said mask pattern has two or more hollows or openings which have predetermined thickness and penetrate said at least a part of X-rays corresponding to each of said micro lens, A manufacturing method of the planar microlens according to claim 1, wherein a caliber of those hollows or an opening is changed in a thickness direction of said mask pattern and it is irradiated with said X-rays by said substrate via this mask pattern.
[Claim 5]An X ray mask pattern which has two or more penetrable openings to said X-rays corresponding to each of said micro lens is substantially arranged in parallel about the surface of said substrate, A manufacturing method of the planar microlens according to claim 1, wherein said mask pattern is vibrated including a two-dimensional vibration component parallel to the field while said X-rays are irradiated by said substrate via said mask pattern.
[Claim 6]A manufacturing method of planar microlens given in one paragraph of claims 1-5, wherein said silica system glass substrate consists of silica glass which does not contain an alloying element.
[Claim 7]A manufacturing method of planar microlens given in one paragraph of claims 1-5, wherein said silica system glass substrate contains at least one chosen from germanium, titanium, a zirconium, Lynn, and aluminum as an alloying element.
[Claim 8]A manufacturing method of the planar microlens according to claim 7, wherein concentration of an alloying element contained in said substrate is changed

about a depth direction.
[Claim 9]A manufacturing method of planar microlens given in one paragraph of claims 1-8, wherein said X-rays include energy of 0.531keV - 10keV within the limits.

[Translation done.]

Drawing selection Representative drawing



[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to facilitation and highly-precise-izing of the manufacturing method especially about the manufacturing method of the planar microlens used as an optical element in a liquid crystal projector, the light-receiving-and-light-emitting circuit for optical communications, a printer, a copying machine, a facsimile, etc.
[0002]
[Description of the Prior Art]In drawing 5, the part is shown by the fracture perspective view and an example of planar microlens is shown in drawing 6 by the rough sectional view where the optical effect of such planar microlens is rough. In these figures, the array of two or more micro lenses 22 is formed in the surface of the glass substrate 20. These micro lenses 22 have a refractive index higher than the host phase of the substrate 20. That is, when the parallel ray 23 enters, the micro lens 22 may produce the operation which condenses those incident light to the focus F, as shown in drawing 6.
[0003]A typical example of the production art of such planar microlens is indicated by "the small optical element for an optical system designer", an optronics company, and the 26th page - 28 pages. In drawing 7, the production art by the typical advanced technology of such planar microlens is illustrated with the rough sectional view.
[0004]In drawing 7 (A), the surface of the glass substrate 20 containing the ion to which the refractive index of glass is reduced is covered with the metallic coating layer 21.
[0005]In drawing 7 (B), the mask pattern 21a containing two or more openings 21b is formed by processing the metallic coating layer 21 using photolithograph art.
[0006]In drawing 7 (C), the glass substrate 20 is immersed into the fused salt containing the ion which raises the refractive index of glass. And the ion to which the refractive index of glass is reduced, and the ion which raises a refractive index are made to exchange only via the opening 21b of the mask 21a, and the micro lens 22 is formed of it as represented and illustrated by the arrow.
[0007]Then, planar microlens is obtained by removing the mask 21 as shown in drawing 7 (D).
[0008]
[Problem(s) to be Solved by the Invention]As mentioned above, the conventional typical manufacturing method of planar microlens needs many processes like formation of a metallic coating layer, formation of the mask by patterning a metallic coating

layer, the ionic exchange through a mask, and removal of a mask, and is complicated. Since it is accompanied by diffusion of ion between ionic exchange in the conventional manufacturing method, it is difficult to produce the planar microlens which has a lens diameter of 10 micrometers or less.
[0009]In view of the technical problem of the manufacturing method of such conventional planar microlens, an object of this invention is to provide the method of simple and manufacturing by low cost for highly precise planar microlens.
[0010]
[Means for Solving the Problem]In a manufacturing method of planar microlens by this invention, it is characterized by raising a refractive index of a field of these plurality locally by preparing a silica system glass substrate, and irradiating a field of these plurality with X-rays so that a micro lens may be produced in each of two or more fields of the substrate.
[0011]Therefore, according to the manufacturing method of planar microlens of this invention, it is complicated like local ionic exchange in a conventional method, and a process that time and effort starts is not needed, but it becomes possible to produce planar microlens simple and with high precision only by irradiating with X-rays locally.
[0012]It is arranged at relative position relation to which an X ray mask pattern which has two or more penetrable openings to X-rays corresponding to each of a micro lens was substantially parallel to, and was preferably fixed about the surface of a substrate. While X-rays are irradiated by substrate via a mask pattern, it is rotated by the surroundings of the fixed axis of rotation parallel to an optic axis of X-rays, a substrate maintaining relative position relation with a mask pattern, and the surface of a substrate does not lie at right angles to the axis of rotation between the rotation. An angle which the surface of a substrate and the axis of rotation make may be changed into X-ray irradiation.
[0013]By irradiating with X-rays with such a form, planar microlens containing a micro lens of two or more convex lens shape may be formed simple.
[0014]About a form of X-ray irradiation, an X ray mask pattern is substantially arranged in parallel on the surface of a substrate. The mask pattern has two or more hollows or openings which have predetermined thickness and penetrate at least a part of X-rays corresponding to each of a micro lens. A caliber of those hollows or an opening is changed in a thickness direction of a mask pattern, and it may be irradiated with X-rays by substrate via this mask pattern.
[0015]Even if it irradiates with X-rays with such a form, planar microlens containing a micro lens of two or more convex lens shape may be produced simple.
[0016]An X ray mask pattern which has two or more penetrable openings to X-rays as a form of X-ray irradiation corresponding to each of a micro lens is substantially arranged in parallel about the surface of a substrate. While X-rays are irradiated by substrate via the mask pattern, a mask pattern may be vibrated including a two-dimensional vibration component parallel to the field.
[0017]Planar microlens containing a micro lens of two or more convex lens shape may be produced simple by such X-ray irradiation of a form.
[0018]Silica glass can be used as a silica system glass substrate, and planar microlens which has very high transmissivity in an infrared area in that case can be obtained.
[0019]On the other hand, a silica system glass substrate may also contain at least one chosen from germanium, titanium, a zirconium, Lynn, and aluminum as an alloying element. In a silica system glass substrate containing such an alloying element, a

rise of a big refractive index is acquired in the same amount of X-ray irradiation compared with silica glass.

[0020]Concentration of an alloying element contained in a silica system glass substrate may be changed about a depth direction. In a silica system glass substrate, an absorbed amount of X-rays becomes small as a position becomes deep. Therefore, when a substrate containing an alloying element distributed uniformly is used for a depth direction, refractive index distribution corresponding to absorption distribution only depending on the depth of X-rays is formed. Although it is possible to form various different refractive index distribution in a depth direction by controlling energy of X-rays at this time, refractive index distribution in a depth direction can be controlled more freely and certainly by using change of concentration distribution in a depth direction of an alloying element. For example, when concentration of an alloying element is increased in connection with the depth of a substrate, formation of a lens with which a refractive index was raised to a deep position is attained. Conversely, a thin lens can be formed in an emergency with a steep refractive index change if concentration of an alloying element is decreasing in connection with the depth in a substrate.

[0021]As for X-rays which should be irradiated, it is preferred to have the energy of 0.531keV - 10keV within the limits. 0. 531keV is the energy of the K edge shell absorption end of oxygen contained in silica system glass, and even if it irradiates with X-rays of an energy level lower than this, a refractive index of silica system glass hardly rises. On the other hand, in X-rays of an energy level of 10 or more keV, an absorbed amount in silica system glass falls about to 1/10 compared with X-rays of 0.531keV. Therefore, a refractive index of silica system glass can be efficiently raised by irradiating with X-rays which have the energy of 0.531keV - 10keV within the limits.

[0022]

[Embodiment of the Invention]In drawing 1, the manufacturing method of the planar microlens by one embodiment of this invention is illustrated with the typical sectional view. First, the silica system glass plate which contains at least one of a silica glass board or germanium, titanium, a zirconium, and the aluminum as an alloying element as the substrate 1 is prepared. These alloying elements have the operation which increases the effect which raises the refractive index of the glass, when silica glass is irradiated by X-rays. When wished, the concentration of these alloying elements may be changed in the thickness direction of a silica system glass substrate. The changing ratio of the thickness in the micro lens formed or a refractive index is controllable using the concentration change of such an alloying element in the thickness direction of a substrate.

[0023]X-ray mask 2 is arranged on the surface of the glass substrate 1. Only a fixed interval may be separated and arranged although X-ray mask 2 is arranged in contact with the surface of the glass substrate 1 in drawing 1. X-ray mask 2 of predetermined thickness contains the array of the opening 2a of the diameter of fixed corresponding to the caliber of the micro lens 5 which should be formed. Such X-ray mask 2 may be formed by processing a metal sheet by the photolithograph method or the X ray RISOGURAFU method, for example. However, the opening 2a here does not necessarily need to be the hole penetrated spatially, and means the field which may pass at least a part of X-rays 4. That is, X-ray mask 2 may process the metal membrane formed on a radiolucent film like a silicon nitride film.

[0024]It is equipped with the glass substrate 1 and X-ray mask 2 on the sample stage 3. And when X-rays 4 are irradiated via X-ray mask 2 to the glass substrate 1, the

sample stage 3 is rotated by the surroundings of the axis of rotation parallel to the optic axis of X-rays 4 as expressed with the arrow 3A. At this time, the surface of the glass substrate 1 does not intersect perpendicularly to this axis of rotation, but is set up make the predetermined angle theta. This angle theta may be changed between X-ray irradiation. In this way, the refractive index of the local area irradiated by X-rays through the opening 2a of the mask 2 among the glass substrates 1 increases, and the micro lens 5 is formed.

[0025]Namely, although X-rays 4 are most irradiated between the rotations 3A of the sample stage 3 near the central part of the opening 2a, Since it is interrupted while a part of X-rays 4 carry out a time jitter with the side attachment wall of the opening 2a with the rotation 3A of the sample stage 3 near the periphery of the opening 2a, the micro lens 5 in which the refractive index was raised to convex lens shape is formed.

[0026]Here, in order to raise the refractive index of silica system glass efficiently, it is preferred to irradiate with the X-rays which have the energy of 0.531keV - 10keV within the limits. That is, 0.531keV is the energy of the K edge shell absorption end of the oxygen contained in silica system glass, and even if it irradiates with the X-rays of an energy level lower than this, the refractive index of silica system glass hardly rises. On the other hand, since the absorbed amount of the X-rays which have the energy of 10 or more keV in silica system glass falls to about [of the absorbed amount of the energy of 0.531keV] 1/10, also when it irradiates with the X-rays which have the energy of 10 or more keV, the efficiency of a refractive-index rise falls remarkably. It is explained by X-ray irradiation in full detail in JP,8-169731,A that the refractive index of silica system glass may be raised.

[0027]In drawing 2, the manufacturing method of the planar microlens by another embodiment of this invention is shown by the typical sectional view. In drawing 2, it is similar with the case of drawing 1, and X-ray mask 6 is arranged on the surface of the glass substrate 1. However, this X-ray mask 6 contains not the breakthrough that has a side attachment wall which intersects perpendicularly with that surface but the array of two or more hollows 6a. Each of these hollows 6a has the caliber gradually decreased toward the glass substrate side from the X line source side.

[0028]The sample stage 3 is equipped with such the glass substrate 1 and X-ray mask 6. The optic axis of X-rays 4 and the surface of the glass substrate 1 and X-ray mask 6 are made to cross at right angles at this time. If X-rays 4 are irradiated by the glass substrate 1 via X-ray mask 6 in such the state, X-rays 4 will penetrate most in the central part of each hollow 6a, and the transmission quantity of X-rays 4 will decrease in the field near the periphery. As a result, the refractive index of the glass substrate 1 is raised more, so that it is close to the center of the hollow 6a, and the micro lens 5 of convex lens shape is formed.

[0029]Although the caliber of the hollow 6a of X-ray mask 6 is decreased toward the glass substrate side from the X line source side in drawing 2, contrary to this, it cannot be overemphasized that the caliber of the hollow 6a may be decreased toward the X-rays side from the glass substrate side. the hollow 6a -- from both the surfaces of X-ray mask 6 -- ****** -- it may have -- the central part of the hollow from both sides may be connected by micropore.

[0030]In drawing 3 and drawing 4, the manufacturing method of the planar microlens of this invention according to the mode of other operations further is illustrated. The front view of drawing 3 is illustrating roughly the X-ray mask used in this

example.

[0031]X-ray mask 2 in drawing 3 contains the array of the opening 2a which has a side attachment wall which intersects perpendicularly with the surface like the case of drawing 1. The frame 7 is equipped with this X-ray mask 2 via the spring 8 and the level drive piezoelectric element 9, and the frame 7 is supported by the vertical-drive piezoelectric element 10. That is, the level drive piezoelectric element 9 and the vertical-drive piezoelectric element 10 can vibrate X-ray mask 2 to a horizontal direction and a perpendicular direction in parallel with the field, respectively.

[0032]The sample stage 3 is equipped with the glass substrate 1, and the X-ray mask of drawing 3 is arranged in parallel with the surface of the substrate 1 as shown in drawing 4. And the array of the micro lens 5 can be formed by irradiating the glass substrate 1 with X-rays 4 via the mask 2, vibrating the mask 2 to a horizontal direction and a perpendicular direction by the piezoelectric elements 9 and 10.

[0033]That is, when X-rays 4 are irradiated in the state where the opening 2a of the mask 2 vibrates to a horizontal direction and a perpendicular direction, compared with the central part of the opening 2a, many X-rays are covered in time in a periphery, and the micro lens 5 in which the refractive index was increased by convex lens shape as the result is formed.

[0034]

[Effect of the Invention]As mentioned above, according to this invention, it becomes possible to manufacture planar microlens simple, without needing the process of complicated a large number like the advanced technology shown in drawing 7. It is not necessary to form an X-ray mask in particular for every glass substrate like the mask 21a in drawing 7, and it can be used repeatedly any number of times.

[0035]Since dotage by it is produced with diffusion of ion in the manufacturing method of drawing 7, formation of a micro lens with a caliber of 10 micrometers or less is difficult, but. Since X-ray irradiation raises a refractive index, without producing such diffusion in the manufacturing method of this invention, formation of the planar microlens containing a micro lens with a detailed caliber of 10 micrometers or less is also attained.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention]This invention relates to facilitation and highly-precise-izing of the manufacturing method especially about the manufacturing method of the planar microlens used as an optical element in a liquid crystal projector, the light-receiving-and-light-emitting circuit for optical communications, a printer, a copying machine, a facsimile, etc.

[Translation done.]

PRIOR ART

[Description of the Prior Art]In drawing 5, the part is shown by the fracture perspective view and an example of planar microlens is shown in drawing 6 by the rough sectional view where the optical effect of such planar microlens is rough. In these figures, the array of two or more micro lenses 22 is formed in the surface of the glass substrate 20. These micro lenses 22 have a refractive index higher than the host phase of the substrate 20. That is, when the parallel ray 23 enters, the micro lens 22 may produce the operation which condenses those incident light to the focus F, as shown in drawing 6.
[0003]A typical example of the production art of such planar microlens is indicated by "the small optical element for an optical system designer", an optronics company, and the 26th page - 28 pages. In drawing 7, the production art by the typical advanced technology of such planar microlens is illustrated with the rough sectional view.
[0004]In drawing 7 (A), the surface of the glass substrate 20 containing the ion to which the refractive index of glass is reduced is covered with the metallic coating layer 21.
[0005]In drawing 7 (B), the mask pattern 21a containing two or more openings 21b is formed by processing the metallic coating layer 21 using photolithograph art.
[0006]In drawing 7 (C), the glass substrate 20 is immersed into the fused salt containing the ion which raises the refractive index of glass. And the ion to which the refractive index of glass is reduced, and the ion which raises a refractive index are made to exchange only via the opening 21b of the mask 21a, and the micro lens 22 is formed of it as represented and illustrated by the arrow.
[0007]Then, planar microlens is obtained by removing the mask 21 as shown in drawing 7 (D).

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention]As mentioned above, according to this invention, it becomes possible to manufacture planar microlens simple, without needing the process of complicated a large number like the advanced technology shown in drawing 7. It is not necessary to form an X-ray mask in particular for every glass substrate like the mask 21a in drawing 7, and it can be used repeatedly any number of times.
[0035]Since dotage by it is produced with diffusion of ion in the manufacturing method of drawing 7, formation of a micro lens with a caliber of 10 micrometers or less is difficult, but. Since X-ray irradiation raises a refractive index, without producing such diffusion in the manufacturing method of this invention, formation of the planar microlens containing a micro lens with a detailed caliber of 10 micrometers or less is also attained.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]As mentioned above, the conventional typical manufacturing method of planar microlens needs many processes like formation of a metallic coating layer, formation of the mask by patterning a metallic coating layer, the ionic exchange through a mask, and removal of a mask, and is complicated. Since it is accompanied by diffusion of ion between ionic exchange in the conventional manufacturing method, it is difficult to produce the planar microlens which has a lens diameter of 10 micrometers or less.
[0009]In view of the technical problem of the manufacturing method of such conventional planar microlens, an object of this invention is to provide the method of simple and manufacturing by low cost for highly precise planar microlens.

[Translation done.]

MEANS

[Means for Solving the Problem]In a manufacturing method of planar microlens by this invention, it is characterized by raising a refractive index of a field of these plurality locally by preparing a silica system glass substrate, and irradiating a field of these plurality with X-rays so that a micro lens may be produced in each of two or more fields of the substrate.
[0011]Therefore, according to the manufacturing method of planar microlens of this invention, it is complicated like local ionic exchange in a conventional method, and a process that time and effort starts is not needed, but it becomes possible to produce planar microlens simple and with high precision only by irradiating with X-rays locally.
[0012]It is arranged at relative position relation to which an X ray mask pattern which has two or more penetrable openings to X-rays corresponding to each of a micro lens was substantially parallel to, and was preferably fixed about the surface of a substrate. While X-rays are irradiated by substrate via a mask pattern, it is rotated by the surroundings of the fixed axis of rotation parallel to an optic axis of X-rays, a substrate maintaining relative position relation with a mask pattern, and the surface of a substrate does not lie at right angles to the axis of rotation between the rotation. An angle which the surface of a substrate and the axis of rotation make may be changed into X-ray irradiation.
[0013]By irradiating with X-rays with such a form, planar microlens containing a micro lens of two or more convex lens shape may be formed simple.
[0014]About a form of X-ray irradiation, an X ray mask pattern is substantially arranged in parallel on the surface of a substrate. The mask pattern has two or more hollows or openings which have predetermined thickness and penetrate at least a part of X-rays corresponding to each of a micro lens. A caliber of those hollows or an opening is changed in a thickness direction of a mask pattern, and it may be irradiated with X-rays by substrate via this mask pattern.
[0015]Even if it irradiates with X-rays with such a form, planar microlens containing a micro lens of two or more convex lens shape may be produced simple.
[0016]An X ray mask pattern which has two or more penetrable openings to X-rays as a form of X-ray irradiation corresponding to each of a micro lens is substantially arranged in parallel about the surface of a substrate. While X-rays are irradiated by substrate via the mask pattern, a mask pattern may be vibrated including a two-dimensional vibration component parallel to the field.
[0017]Planar microlens containing a micro lens of two or more convex lens shape may be produced simple by such X-ray irradiation of a form.
[0018]Silica glass can be used as a silica system glass substrate, and planar

microlens which has very high transmissivity in an infrared area in that case can be obtained.
[0019]On the other hand, a silica system glass substrate may also contain at least one chosen from germanium, titanium, a zirconium, Lynn, and aluminum as an alloying element. In a silica system glass substrate containing such an alloying element, a rise of a big refractive index is acquired in the same amount of X-ray irradiation compared with silica glass.
[0020]Concentration of an alloying element contained in a silica system glass substrate may be changed about a depth direction. In a silica system glass substrate, an absorbed amount of X-rays becomes small as a position becomes deep. Therefore, when a substrate containing an alloying element distributed uniformly is used for a depth direction, refractive index distribution corresponding to absorption distribution only depending on the depth of X-rays is formed. Although it is possible to form various different refractive index distribution in a depth direction by controlling energy of X-rays at this time, refractive index distribution in a depth direction can be controlled more freely and certainly by using change of concentration distribution in a depth direction of an alloying element. For example, when concentration of an alloying element is increased in connection with the depth of a substrate, formation of a lens with which a refractive index was raised to a deep position is attained. Conversely, a thin lens can be formed in an emergency with a steep refractive index change if concentration of an alloying element is decreasing in connection with the depth in a substrate.
[0021]As for X-rays which should be irradiated, it is preferred to have the energy of 0.531keV - 10keV within the limits. 0. 531keV is the energy of the K edge shell absorption end of oxygen contained in silica system glass, and even if it irradiates with X-rays of an energy level lower than this, a refractive index of silica system glass hardly rises. On the other hand, in X-rays of an energy level of 10 or more keV, an absorbed amount in silica system glass falls about to 1/10 compared with X-rays of 0.531keV. Therefore, a refractive index of silica system glass can be efficiently raised by irradiating with X-rays which have the energy of 0.531keV - 10keV within the limits.
[0022]
[Embodiment of the Invention]In drawing 1, the manufacturing method of the planar microlens by one embodiment of this invention is illustrated with the typical sectional view. First, the silica system glass plate which contains at least one of a silica glass board or germanium, titanium, a zirconium, and the aluminum as an alloying element as the substrate 1 is prepared. These alloying elements have the operation which increases the effect which raises the refractive index of the glass, when silica glass is irradiated by X-rays. When wished, the concentration of these alloying elements may be changed in the thickness direction of a silica system glass substrate. The changing ratio of the thickness in the micro lens formed or a refractive index is controllable using the concentration change of such an alloying element in the thickness direction of a substrate.
[0023]X-ray mask 2 is arranged on the surface of the glass substrate 1. Only a fixed interval may be separated and arranged although X-ray mask 2 is arranged in contact with the surface of the glass substrate 1 in drawing 1. X-ray mask 2 of predetermined thickness contains the array of the opening 2a of the diameter of fixed corresponding to the caliber of the micro lens 5 which should be formed. Such X-ray mask 2 may be formed by processing a metal sheet by the photolithograph method or the X ray RISOGURAFU method, for example. However, the opening 2a here does not

necessarily need to be the hole penetrated spatially, and means the field which may pass at least a part of X-rays 4. That is, X-ray mask 2 may process the metal membrane formed on a radiolucent film like a silicon nitride film.
[0024]It is equipped with the glass substrate 1 and X-ray mask 2 on the sample stage 3. And when X-rays 4 are irradiated via X-ray mask 2 to the glass substrate 1, the sample stage 3 is rotated by the surroundings of the axis of rotation parallel to the optic axis of X-rays 4 as expressed with the arrow 3A. At this time, the surface of the glass substrate 1 does not intersect perpendicularly to this axis of rotation, but is set up make the predetermined angle theta. This angle theta may be changed between X-ray irradiation. In this way, the refractive index of the local area irradiated by X-rays through the opening 2a of the mask 2 among the glass substrates 1 increases, and the micro lens 5 is formed.
[0025]Namely, although X-rays 4 are most irradiated between the rotations 3A of the sample stage 3 near the central part of the opening 2a, Since it is interrupted while a part of X-rays 4 carry out a time jitter with the side attachment wall of the opening 2a with the rotation 3A of the sample stage 3 near the periphery of the opening 2a, the micro lens 5 in which the refractive index was raised to convex lens shape is formed.
[0026]Here, in order to raise the refractive index of silica system glass efficiently, it is preferred to irradiate with the X-rays which have the energy of 0.531keV - 10keV within the limits. That is, 0.531keV is the energy of the K edge shell absorption end of the oxygen contained in silica system glass, and even if it irradiates with the X-rays of an energy level lower than this, the refractive index of silica system glass hardly rises. On the other hand, since the absorbed amount of the X-rays which have the energy of 10 or more keV in silica system glass falls to about [of the absorbed amount of the energy of 0.531keV] 1/10, also when it irradiates with the X-rays which have the energy of 10 or more keV, the efficiency of a refractive-index rise falls remarkably. It is explained by X-ray irradiation in full detail in JP,8-169731,A that the refractive index of silica system glass may be raised.
[0027]In drawing 2, the manufacturing method of the planar microlens by another embodiment of this invention is shown by the typical sectional view. In drawing 2, it is similar with the case of drawing 1, and X-ray mask 6 is arranged on the surface of the glass substrate 1. However, this X-ray mask 6 contains not the breakthrough that has a side attachment wall which intersects perpendicularly with that surface but the array of two or more hollows 6a. Each of these hollows 6a has the caliber gradually decreased toward the glass substrate side from the X line source side.
[0028]The sample stage 3 is equipped with such the glass substrate 1 and X-ray mask 6. The optic axis of X-rays 4 and the surface of the glass substrate 1 and X-ray mask 6 are made to cross at right angles at this time. If X-rays 4 are irradiated by the glass substrate 1 via X-ray mask 6 in such the state, X-rays 4 will penetrate most in the central part of each hollow 6a, and the transmission quantity of X-rays 4 will decrease in the field near the periphery. As a result, the refractive index of the glass substrate 1 is raised more, so that it is close to the center of the hollow 6a, and the micro lens 5 of convex lens shape is formed.
[0029]Although the caliber of the hollow 6a of X-ray mask 6 is decreased toward the glass substrate side from the X line source side in drawing 2, contrary to this, it cannot be overemphasized that the caliber of the hollow 6a may be decreased toward the X-rays side from the glass substrate side. the hollow 6a -- from both the

surfaces of X-ray mask 6 -- ****** -- it may have -- the central part of the hollow from both sides may be connected by micropore.
[0030]In drawing 3 and drawing 4, the manufacturing method of the planar microlens of this invention according to the mode of other operations further is illustrated. The front view of drawing 3 is illustrating roughly the X-ray mask used in this example.
[0031]X-ray mask 2 in drawing 3 contains the array of the opening 2a which has a side attachment wall which intersects perpendicularly with the surface like the case of drawing 1. The frame 7 is equipped with this X-ray mask 2 via the spring 8 and the level drive piezoelectric element 9, and the frame 7 is supported by the vertical-drive piezoelectric element 10. That is, the level drive piezoelectric element 9 and the vertical-drive piezoelectric element 10 can vibrate X-ray mask 2 to a horizontal direction and a perpendicular direction in parallel with the field, respectively.
[0032]The sample stage 3 is equipped with the glass substrate 1, and the X-ray mask of drawing 3 is arranged in parallel with the surface of the substrate 1 as shown in drawing 4. And the array of the micro lens 5 can be formed by irradiating the glass substrate 1 with X-rays 4 via the mask 2, vibrating the mask 2 to a horizontal direction and a perpendicular direction by the piezoelectric elements 9 and 10.
[0033]That is, when X-rays 4 are irradiated in the state where the opening 2a of the mask 2 vibrates to a horizontal direction and a perpendicular direction, compared with the central part of the opening 2a, many X-rays are covered in time in a periphery, and the micro lens 5 in which the refractive index was increased by convex lens shape as the result is formed.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a rough sectional view for explaining the manufacturing method of the planar microlens by one embodiment of this invention.
[Drawing 2]It is a rough sectional view for explaining the manufacturing method of the planar microlens by another embodiment of this invention.
[Drawing 3]It is a rough front view of an X-ray mask used for the manufacturing method of the planar microlens by the mode of further others of this invention.
[Drawing 4]It is a rough sectional view for explaining how to produce planar microlens using the X-ray mask of drawing 3.
[Drawing 5]an example of publicly known planar microlens is shown -- rough -- it is a fracture perspective view in part.
[Drawing 6]It is a rough sectional view for explaining the optical effect of planar microlens as shown in drawing 5.
[Drawing 7]It is a rough sectional view illustrating the manufacturing method of the conventional planar microlens.
[Description of Notations]
1 Silica system glass substrate
2 X-ray mask
2a Opening
3 Sample stage
3a The axis of rotation of a sample stage
4 X-rays
5 Micro lens
6 X-ray mask
6a Hollow
7 X-ray mask holding frame
8 Spring
9 Level drive piezoelectric element
10 Vertical-drive piezoelectric element

[Translation done.]

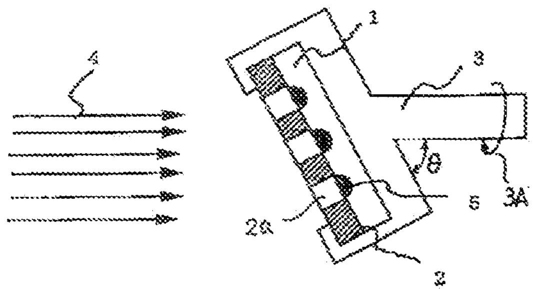
* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

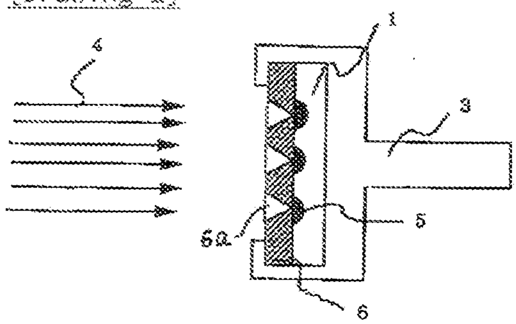
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

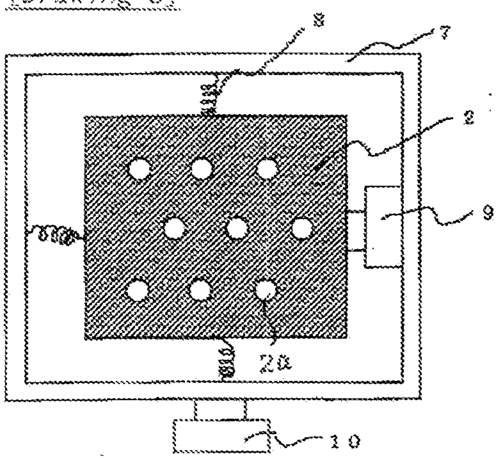
[Drawing 1]



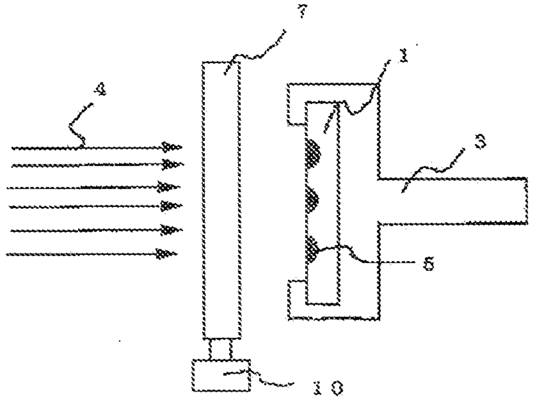
[Drawing 2]



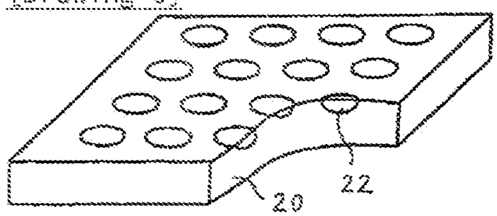
[Drawing 3]



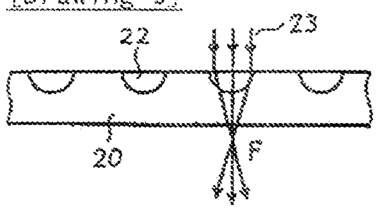
[Drawing 4]



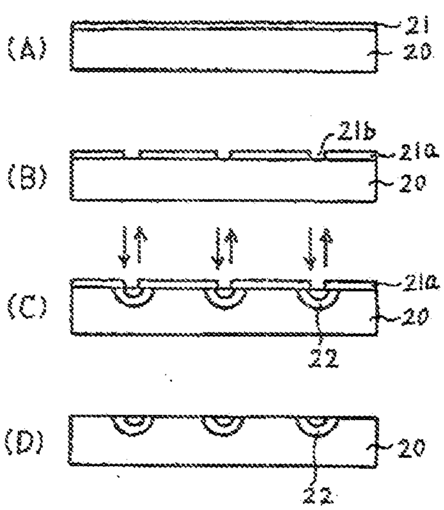
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]